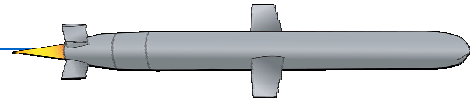

Tactical Tomahawk Weapon System Developmental/Operational Testing
Testing a System of Systems

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13 December 2005

NAVAIR

Report Documentation Page

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OMB No. 0704-0188

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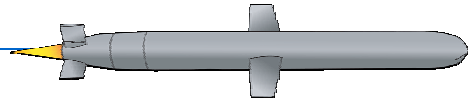
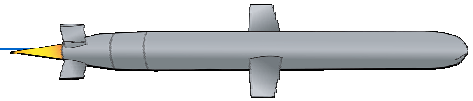
Agenda



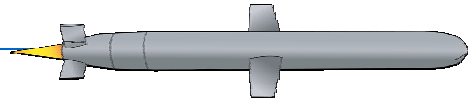
- Background
- DT/OT Test Structure
- Lessons Learned
- Summary

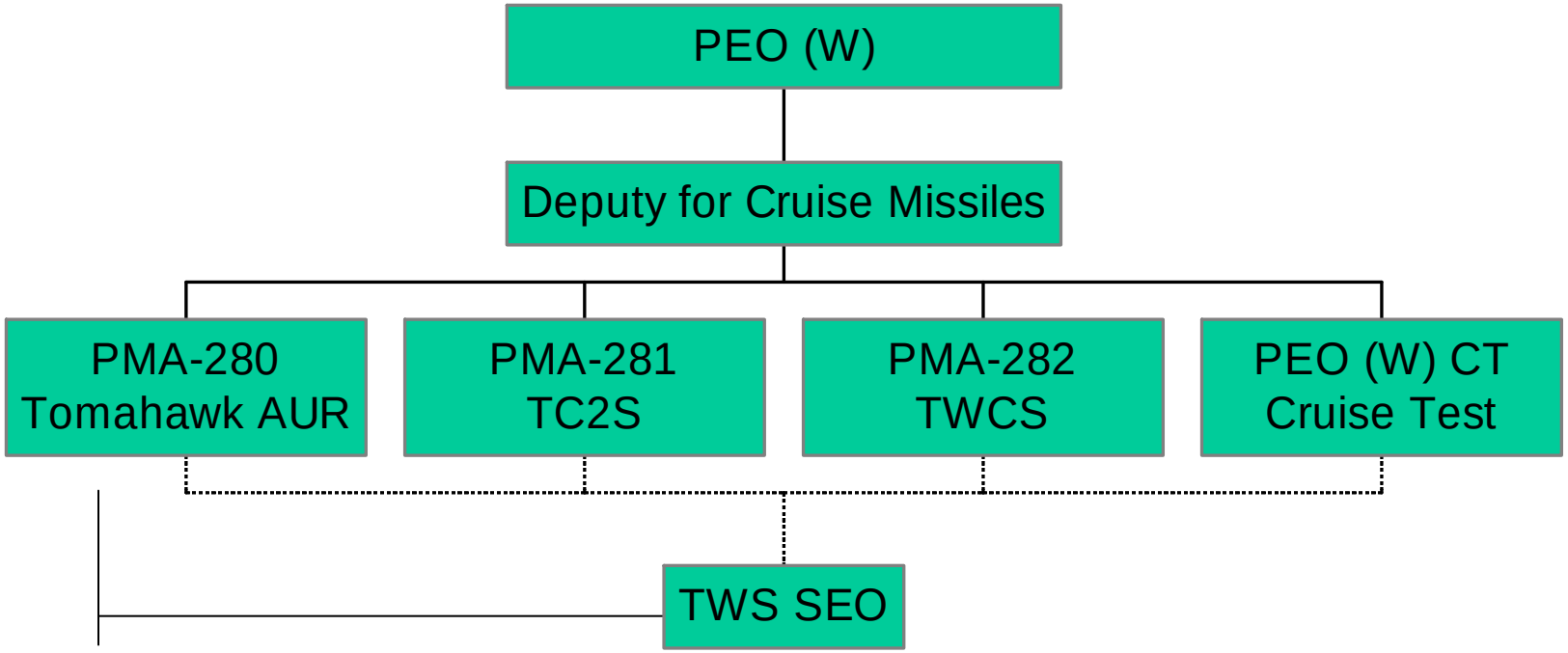
Background



- Tomahawk is an integrated set of independently procured elements
- The Tomahawk Weapons System has been using modeling and simulation (M&S) for development, test and sustainment since the programs inception
- The Tomahawk program has been practicing M&S management and verification, validation, and accreditation (VV&A) since 1983

Tomahawk Weapons System Organization

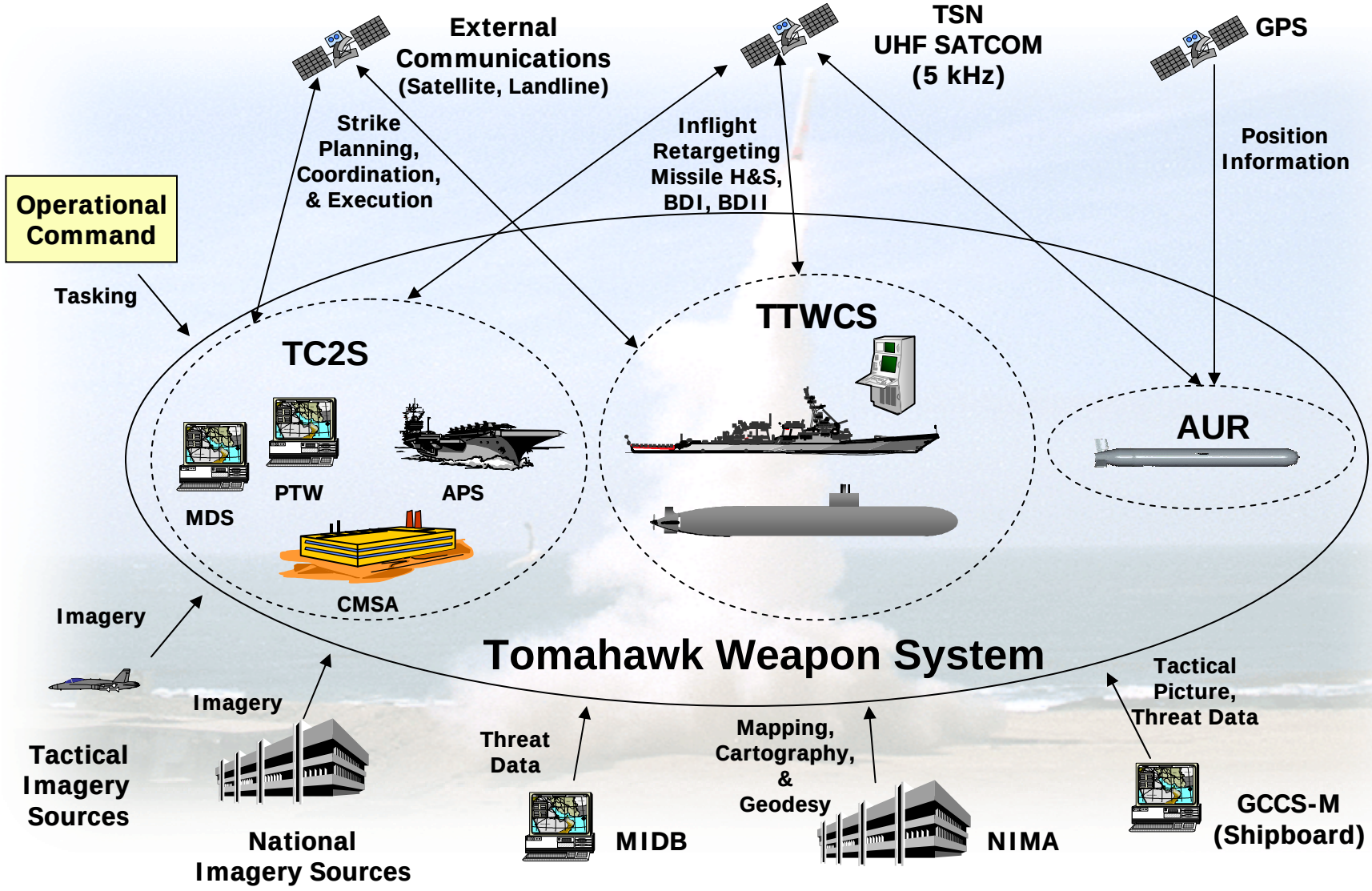




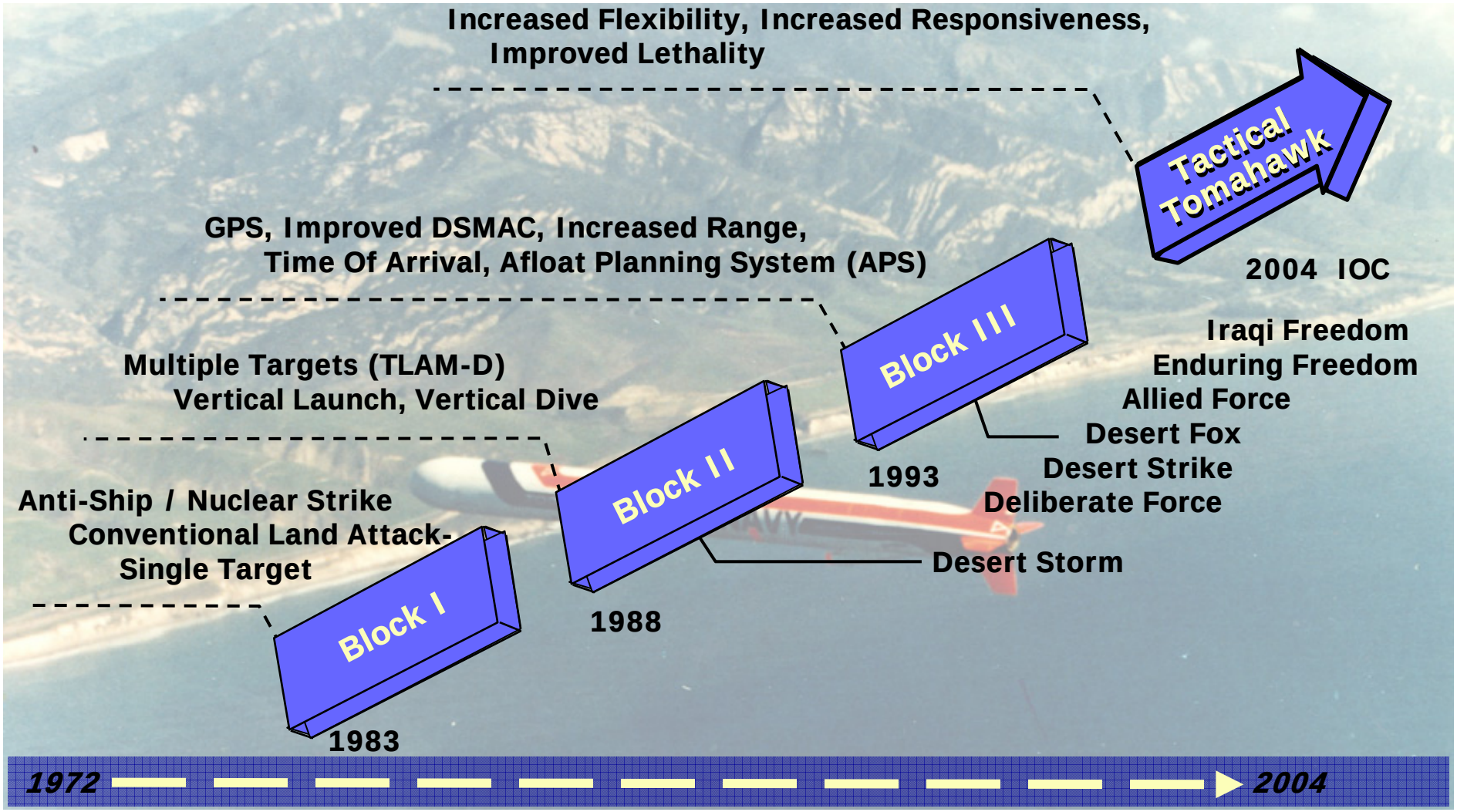
PEO (W) – Program Executive Office for Strike Weapons and Unmanned Aviation
AUR - All Up Round
TWS - Tomahawk Weapons System
SEO - Systems Engineering Organization
TWCS - Tomahawk Weapon Control System
TC2S - Tomahawk Command and Control System

Note: Organization at time of test, has recently changed

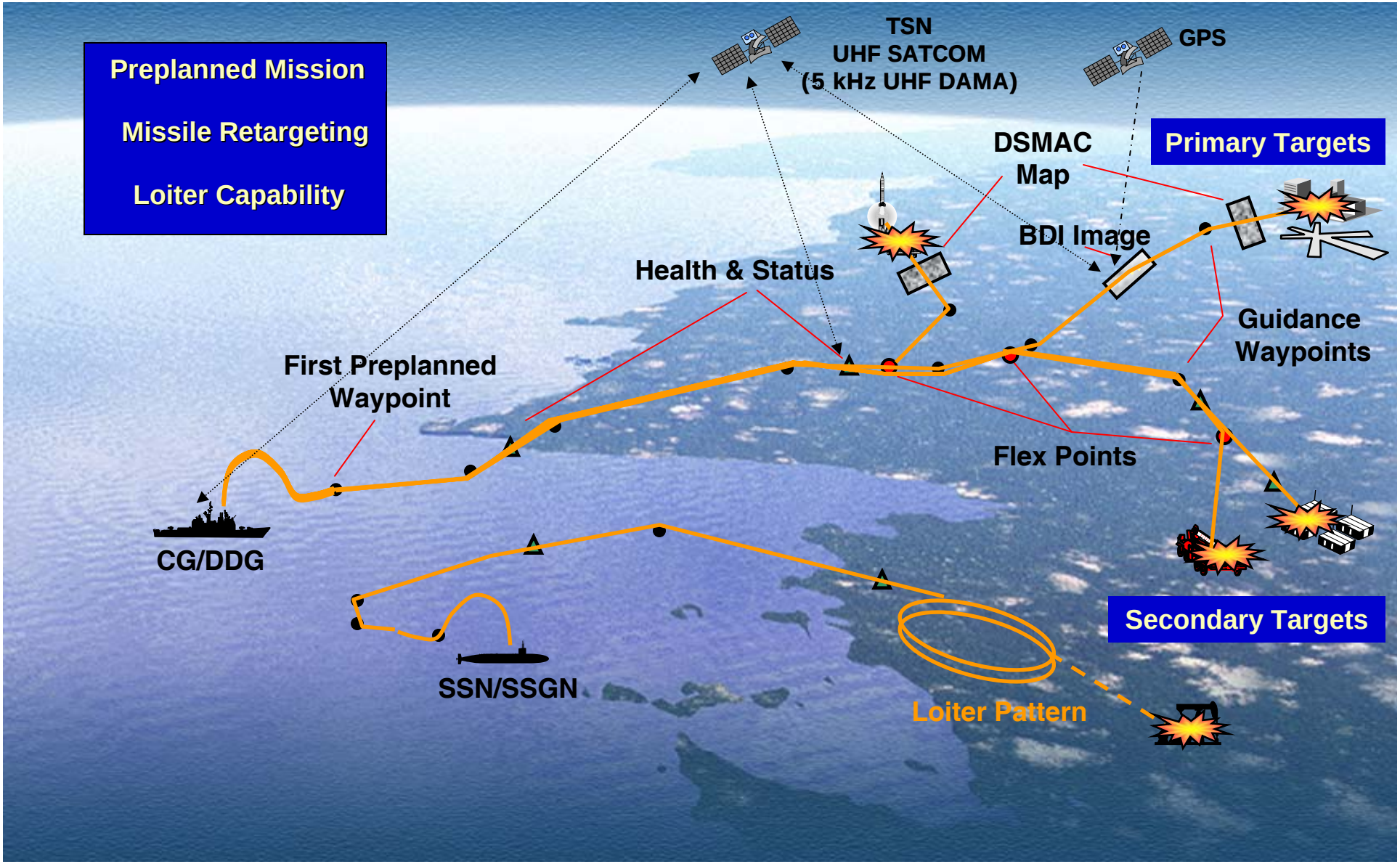
Tomahawk
System of Systems



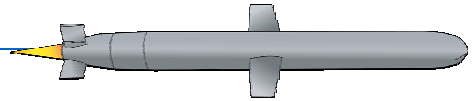
Tomahawk Development History



Blk IV Mission Flexibility and Responsiveness



Tomahawk Command and Control System



Strike Tasking
- Mission Objectives to CMSA / APS / C2

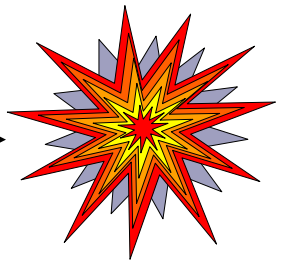
Mission Planning (TMPC / APS)

PTW & DIWS	DIWS & TPS	TPS & MDS
Target Development and Weaponeering	Route Planning and Evaluation	Mission Verification

Mission Distribution System
- MDU / DTD / TCI

Strike Execution
- Strike Coordination Aids
- Missile/Mission Inventories
- Post Strike Analysis/Evaluation

Strike



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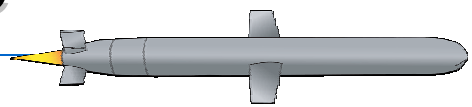
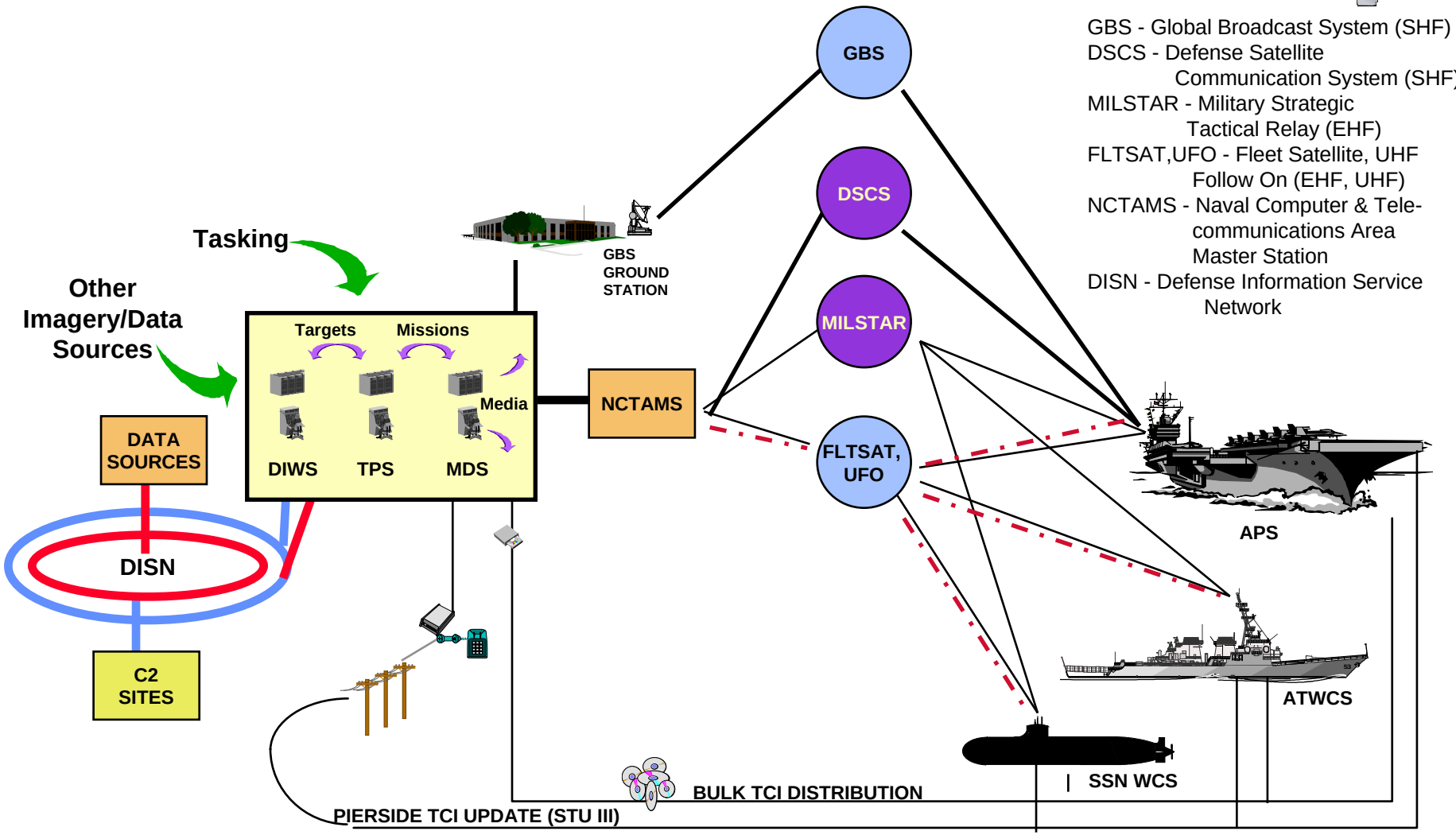
Tomahawk Communication Information Infrastructure



GBS - Global Broadcast System (SHF)
DSCS - Defense Satellite Communication System (SHF)
MILSTAR - Military Strategic Tactical Relay (EHF)
FLTSAT,UFO - Fleet Satellite, UHF Follow On (EHF, UHF)
NCTAMS - Naval Computer & Tele-communications Area Master Station
DISN - Defense Information Service Network



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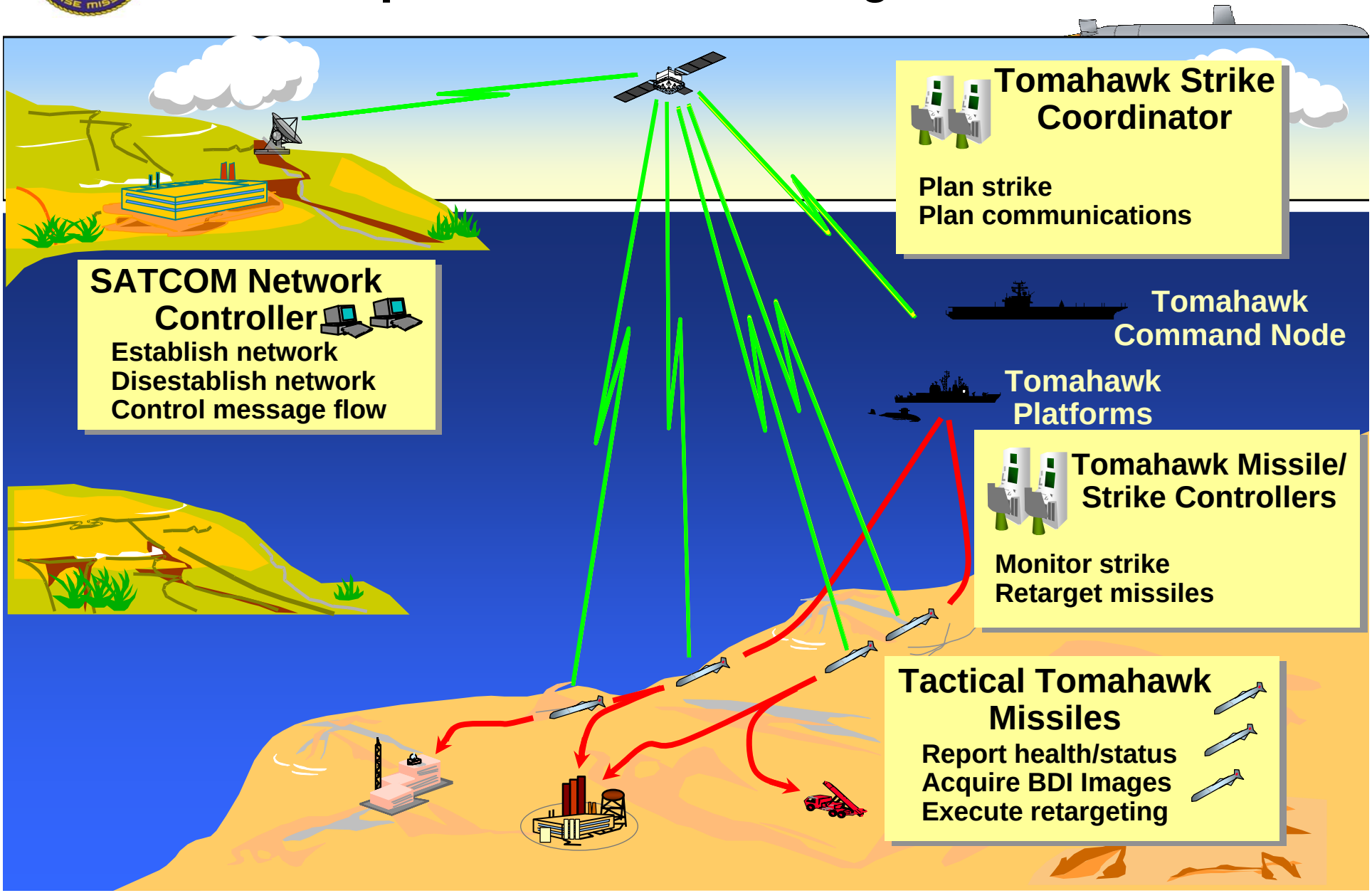
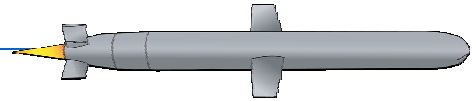
Tomahawk Strike Network
is composed of the following elements:

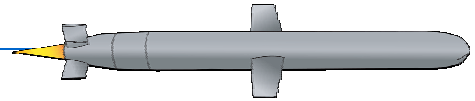


Test Challenges



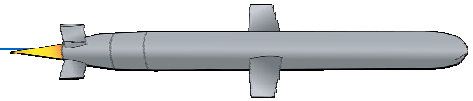
- Satellite communications access
- Communications network loading
- Simulation capability evolution
- Multiple launch platforms
- Geographically dispersed assets
- Test coordination communications
- Large strike – hundreds of missiles in the air

Simulations Used for Test



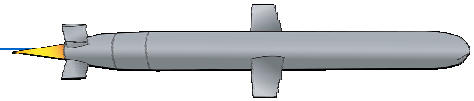
- Mission Validation System Tomahawk Engineering Simulation/Monte Carlo (MVS TES/MC)
- Mission Validation System/Register Level Simulation (MVS/RLS)
- Tactical Simulation (TACSIM)
- Tomahawk Advanced Flight Simulation/Monte Carlo (TAFS-T/MC)
- Missile Communications Simulation (MCS)
- Tactical Tomahawk Multi-Missile Communications Simulator (TTMMCS)
- Shipboard Environment & Missile Simulation with Functional Ground Test (SEMS-SHA)
- Land Attack Systems Integration Laboratory (LASIL)
- Register Level Simulation, Tomahawk Missile in the Loop (RLS/TMIL)

TECHEVAL Test Events



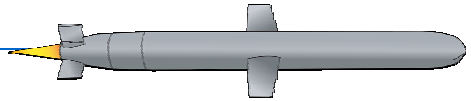
- Shipboard Weapon Control Test Events
  - SWEF - Land Based TTWCS/PCMDS Testing
  - Surface Combat Systems Testing – Pier side
  - Surface Combat Systems Testing – At-Sea
  - LASIL - Land Based TTWCS/PCMDS Testing
- Submarine Weapon Control Test Events
  - CCSL Testing – Land Based
  - Submarine Combat Systems Testing - Pier-side
  - Submarine Combat Systems Testing – At-Sea
- Command and Control Test Events
  - Mission Planning
  - Strike Planning
- Flight Test Events
- Multi-Ship End-to-End Test Events
  - Multi-Ship End-to-End Lab Test
  - Battle Group End-to-End At-Sea Test
  - Full Test Configuration Battle Group End-to-End At-Sea Test
    - Operational Test Dry-Run (OTDR)

OT Test Configuration

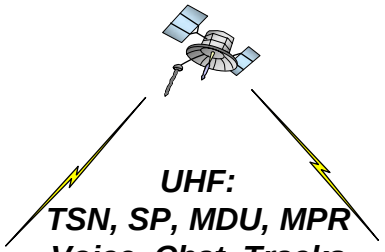


OT Event \ Test Asset	USS STETHEM	USS TUCSON	TTGP	EWTGPAC	STT	NSWC DD	NUWC Npt	ATWCS Ship	AOSDLANT	NSWC Corona	UHF SATCOM	EHF SATCOM	TTMMCS
Event 1: 96 Hour Scenerio	X	X	X	X	X	X	X	X	X	X	X	X	X
Event 2 : Flight Tests	X	X	X								X	X	
Event 3: LASIL						X							
Event 4: Mission Planning & Validation	X	X							X				

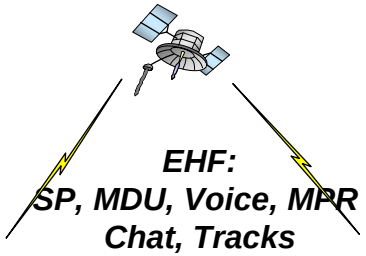
DT-IIC End-to-End @ Sea



Satellite Comms

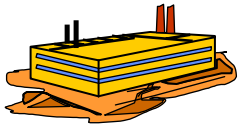


UHF:
TSN, SP, MDU, MPR
Voice, Chat, Tracks

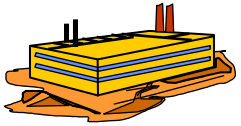


EHF:
SP, MDU, Voice, MPR
Chat, Tracks

Command and Control

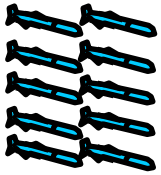


WPC
(TACSIM)



TSC/SACC/
Strike Controller

TACTRAGRUPAC



TTMMS-DT

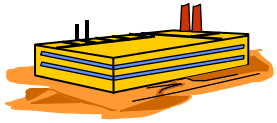
APL

NSWC/IHD
(TAFS/TMIL)

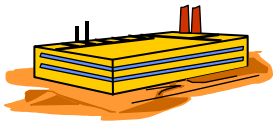
Firing Units

DDG-63

(Tactical Mode +
TMEUs/MK 96s)

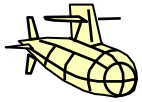


NSWC/DD
(TTWCS/ATWCS in tactical mode/
IDSIM)



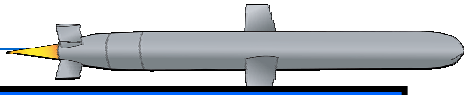
NUWC/NPT
(TTWCS in tactical mode/
MK 101)

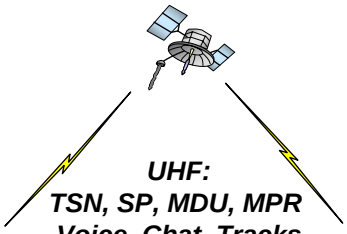
TBD SSN

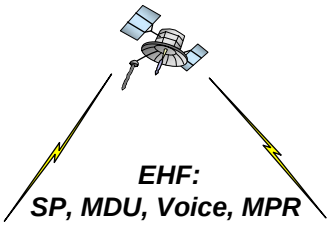


(Tactical Mode +
Mk 101)

OTDR Test Goals/Participants

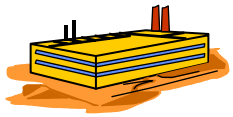




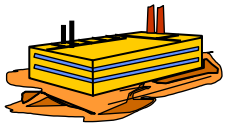


Satellite Comms

Test Goals:
- **Comprehensive System End-to-End Test**
- **Mimic OT 96 HR Scenario**
- **Demonstrate System Functionality from Mission Planning to Target Engagement**
- **Exercise External Interfaces in a simulated tactical environment**

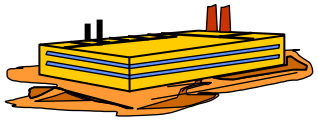


NSWC Corona (Contact Broadcast)

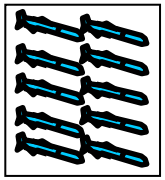


AOSDLANT / WPC (Mission Planning)

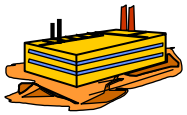
TACTRAGRUPAC



TSC/LAC/SC (TFCC) Alt SC, SACC (PCC)



TTMMCS

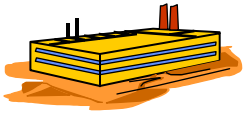


STT, HI (Alt SC)

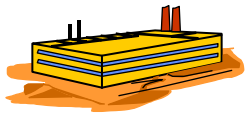
Command and Control

DDG-63
(Missile Controller)

(Tactical Mode + TMEUs, MK96, M683s)



USS NSWC
(TTWCS in tactical mode + VLSS)



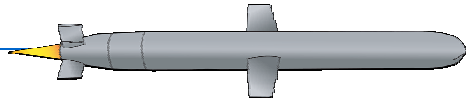
USS NUWC
(TTWCS in tactical mode/ MK 101)

SSN 770
(Missile Controller)

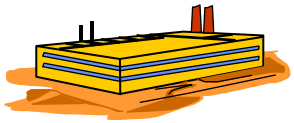
(Tactical Mode + Mk 101 Sim)

Firing Units

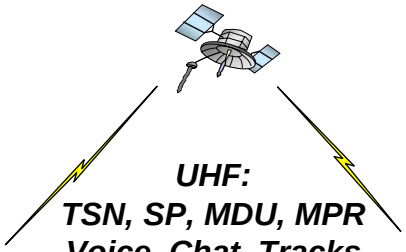
OT-IIC End-to-End @ Sea



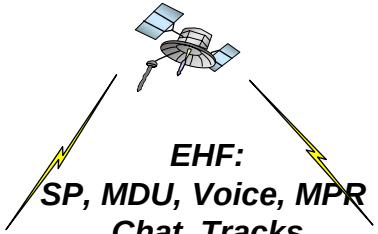
Satellite Comms



NSWC Corona
(Contact broadcast)

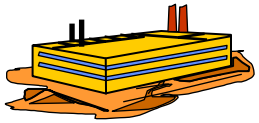


UHF:
TSN, SP, MDU, MPR
Voice, Chat, Tracks



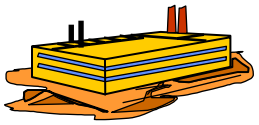
EHF:
SP, MDU, Voice, MPR
Chat, Tracks

Command and Control

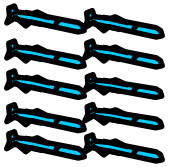


CMSAPAC

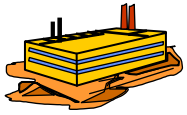
TACTRAGRUPAC



TSC/SACC/
Strike Controller



TTMMS-OT



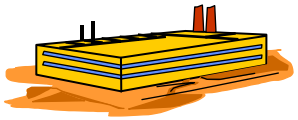
STT, HI
(Alt SC)

Forward Observers
(Satcom voice)

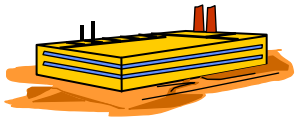
Firing Units

DDG-63

(Tactical Mode +
TMEUs/MK 96s)

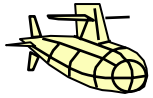


NSWC/DD
(TTWCS in tactical mode
+ IDSIM)



NUWC/NPT
(TTWCS in tactical mode/
MK 101)

TBD Shooter



(Tactical Mode +
Mk 101 Sim)

ATWCS
Shooter

(Training Mode)

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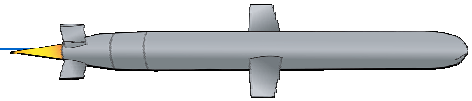
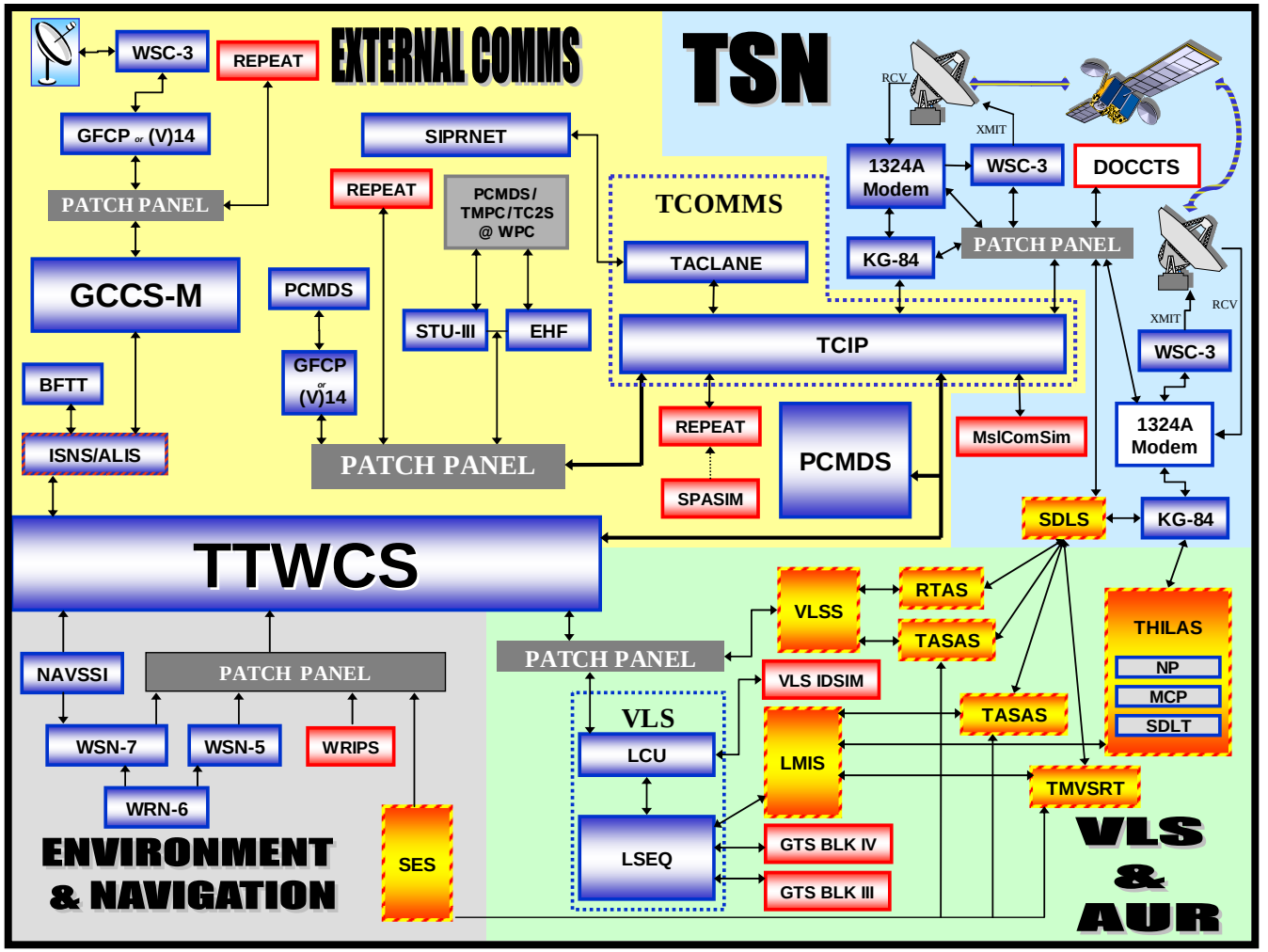
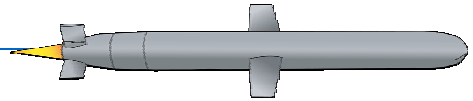
Land Attack Systems Integration Laboratory





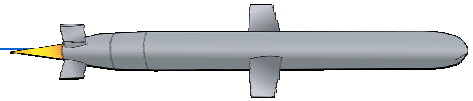
Tactical Equipment | Simulation Equipment | SEMS Equipment

Lessons Learned



- All interfaces, external and internal must be well documented and under configuration management
- Don't assume that legacy performance is as advertised or documented – characterized, model & simulate
- Planning must start years in advance
  - Some simulations took 4 years to define, develop and accredit
  - Live asset scheduling
- M&S MUST be used to adequately develop, test and sustain large scale complex systems
- M&S MUST have advocacy for the program to be a success
  - Resources
  - Policy
- A robust M&S VV&A process essential
  - Established by policy
  - Needed to support OTA accreditation
  - M&S accreditation finds software defects
  - Accredit with the end-user in mind
  - Establish and promote site accreditation

Summary



- Tomahawk continues to pioneer the use of M&S in large scale *systems of systems* testing
- VV&A applies to the whole test configuration – not just traditionally defined M&S
  - Test sites
  - Test configurations

Bottom Line: You MUST use M&S to test complex systems but… the limitations and characteristics of the M&S must be clearly understood in order to get accurate results

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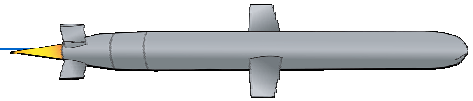
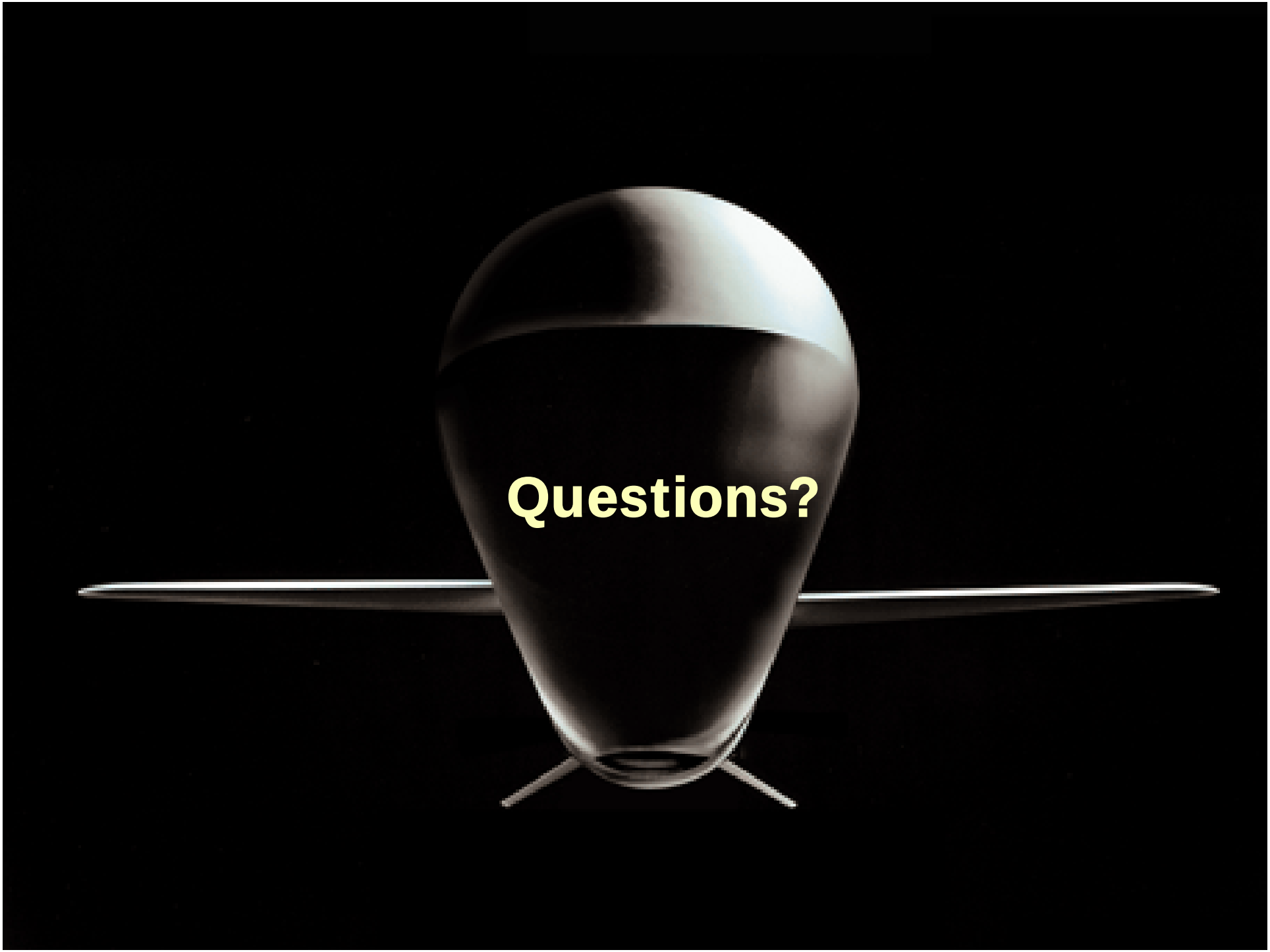
Acronym List



- APS – Afloat Planning System
- ATWCS – Advanced Tomahawk Weapons Control System
- AUR – All Up Round
- BDI – Battle Damage Indication
- BDII – Battle Damage Indication Imagery
- CCSL – Combat Control System Laboratory
- CMSA – Cruise Missile Support Activity
- DAMA – Demand Assigned Multiple Access
- DISN – Defense Information Service Network
- DIWS – Digital Imagery Work Station
- DT – Development Testing
- DTD – Data Transport Devices
- DSCS – Defense Satellite Communications System
- DSMAC – Digital Scene Mapping Area Correlation
- FLTSAT, UFO – Fleet Satellite, UHF Follow On
- GBS – Global Broadcast System
- GCCS-M – Global Command and Control System Maritime
- GPS – Global Positioning System
- IOC – Initial Operational Capability
- LASIL – Land Attack Systems Integration Laboratory
- MDS – Mission Distribution System
- MDU – Mission Data Updates
- MIDB – Modernized Integrated Database
- MILSTAR – Military Strategic Tactical Relay
- NIMA – National Imagery and Mapping Agency
- NCTAMS – Naval Computer & Telecommunications Area Master Station
- OT – Operational Testing
- PCMDS – Personal Computer Mission Distribution System
- PTW – Precision Targeting Workstation
- SWEF – Surface Warfare Engineering Facility
- TCI – Tomahawk Command Information
- TC2S – Tomahawk Command and Control Segment
- TERCOM – Terrain Contour Matching
- TPS – Tomahawk Planning System
- TSN – Tomahawk Strike Network
- TTMMCS – Tactical Tomahawk Multi-Missile Communications Simulator
- TTWCS – Tactical Tomahawk Weapons Control System
- WCS – Weapons Control System


Questions?